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SILVICAL CHARACTERISTICS OF JEFFREY PINE

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Preface

The Forest Service is engaged in assembling information on the silvical characteristics of important forest trees of the United States. Much material that is of value in silviculture and research is widely scattered and difficult to locate. This report presents, in preliminary form, the information that has been collected for one species of tree. Similar reports are being prepared for other species at the California Forest and Range Experiment Station and at other forest experiment stations. Readers are encouraged to notify the authors of omissions, errors, or new information affecting the silvical characteristics of the species.

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By William E. Hallin
Division of Forest Management Research

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SILVICAL CHARACTERISTICS OF JEFFREY PINE

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The most noteworthy feature of Jeffrey pine (Pinus jeffreyi Grev. & Balf.) is its similarity in appearance and behavior to ponderosa pine (Pinus ponderosa Laws.)--a much more widespread and better known species. At one time Jeffrey pine was considered to be a variety of ponderosa pine, and lumber markets make no distinction between the two species because their wood differs little in structure and properties. Because of the apparent similarity of silvical characteristics and wood, usually no distinction has been made between the two species in either management or research records.

Jeffrey pine is found in southwestern Oregon, the Coast Range of California, the Sierra Nevada--including the eastern slopes a short distance into Nevada, southern California, and northern Lower California (Fig. 1).

Jeffrey pine is believed to be an old stable species, whereas ponderosa pine is a young, vigorous, and variable species (12). The relative youthfulness of ponderosa pine as a species probably accounts for its more widespread distribution.

HABITAT CONDITIONS

CLIMATIC

With but few exceptions the climate of Jeffrey pine habitats is characterized by dry summers and cold winters. Minimum temperatures are -25° F. or lower, and maximum temperatures are near or above 100° F. Most of the precipitation falls as snow. In some years summer thundershowers may add appreciably to the precipitation. Contrary to some reports (19), Jeffrey pine probably does not require more moisture than ponderosa pine. Good nearly pure stands are present where the average annual precipitation is only 18 inches. However, Jeffrey pine, like ponderosa pine, grows most rapidly where the annual precipitation averages greater than 30 inches.

Jeffrey pine appears to be more frost resistant than ponderosa pine. In northeastern California on timbered flats and around the borders of non-timbered flats, which probably are frost pockets, Jeffrey pine is more prevalent than ponderosa pine. In these places, the stands are frequently nearly pure Jeffrey pine. On the slopes, however, the stands commonly are pure ponderosa

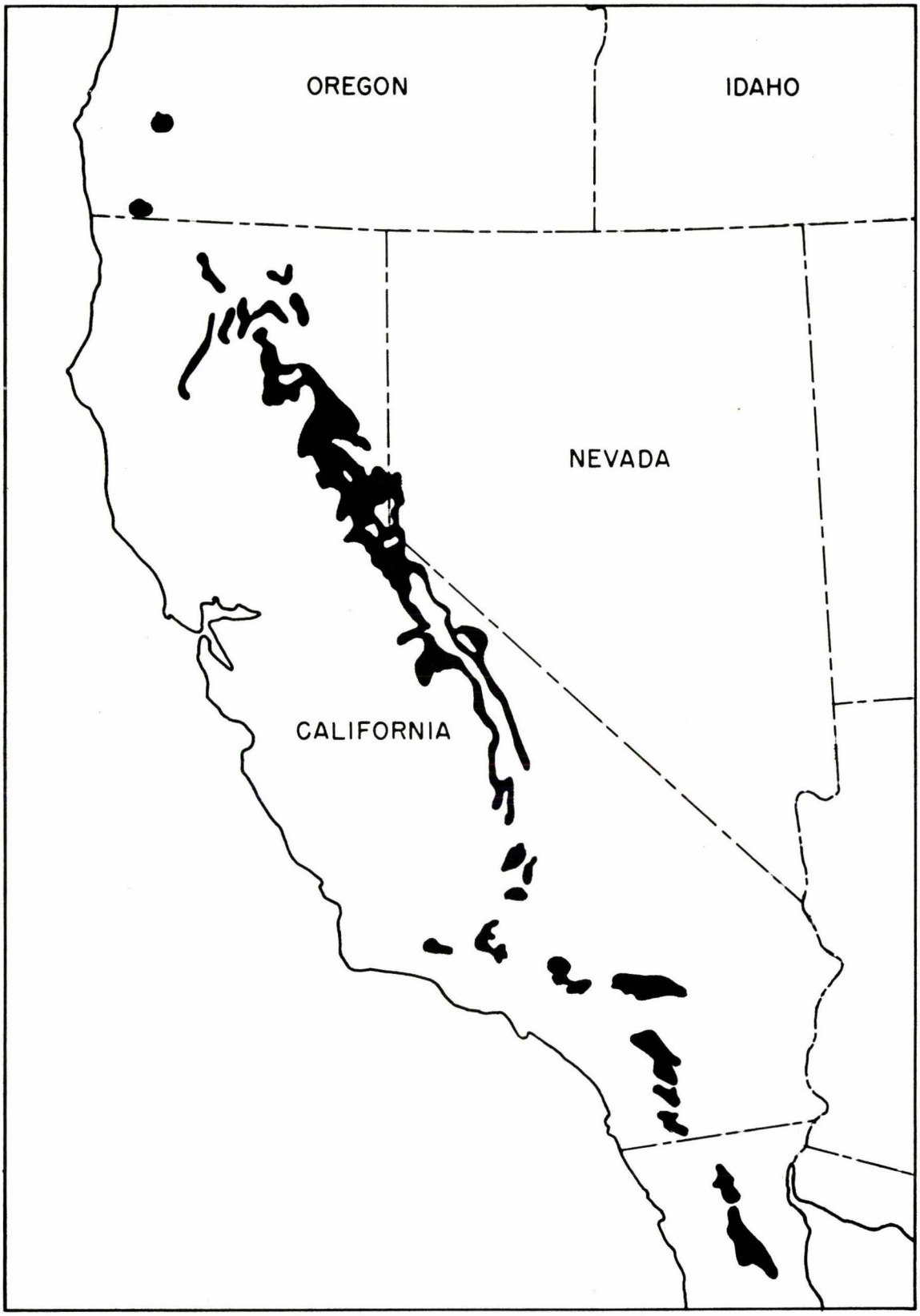

Figure 1.--The natural range of Jeffrey pine. (From Munns, E. N. 1938. The distribution of important forest trees of the United States. U. S. Dept. Agr. Misc. Pub. 287, 176 pp.)

pine. On the west side of the Sierra Nevada Jeffrey pine is more prevalent than ponderosa pine on the colder flats, but seldom grows on the slopes above. On high cold ridges in almost pure true-fir forests, Jeffrey pine is frequently present while ponderosa pine is not.

Nevertheless, Jeffrey pine may have a much more sharply defined low temperature limit than ponderosa pine, according to unpublished observations by Willis W. Wagener of the California Forest and Range Experiment Station. During the winter of 1936-1937, cold weather injured pines the entire length of the east slope of the Sierra Nevada. Foliage of both species was severely injured; twigs, bark, and buds of ponderosa pine were not seriously injured, but Jeffrey pine branches were often completely killed. Evidently a sharply delineated temperature inversion occurred within the cold air layer. Many saplings or small poles of Jeffrey pine were frozen back at the base but remained alive at the top until the trees died later because of the killing below. This type of killing indicates that the margin between little or no injury and mortality from cold is very narrow for Jeffrey pine.

Jeffrey pine commonly occurs in the Canadian life zone and the upper elevation of the Transition zone.

EDAPHIC

In its range Jeffrey pine grows on much the same wide variety of soil as ponderosa pine. It is most common on soils developed from lava flows and granite. In addition it is rather commonly found on soils developed from serpentine rock and is more capable of growth on such soils than ponderosa pine. The occurrence of Jeffrey pine on serpentine soils indicates it can tolerate low levels of calcium, available molybdenum, and major nutrients, and high levels of nickel, chromium, and magnesium (21). Although Jeffrey pine reaches its best development on deep, well-drained soils, it also is found in stunted form on very shallow soils and in crevices in rocks. Lindsay claims that nowhere is Jeffrey pine found on poorly drained soils (10).

PHYSIOGRAPHIC

Except in southern and Lower California and a few places in southwestern Oregon, Jeffrey pine generally grows above 5,000 feet (10). It is found down to 3,500 feet in southern California and down to 4,000 feet in Lower California. In interior northern California it occasionally is found down to 3,500 feet. The lowest known incidence in California is at 1,000 feet above sea level in the Coast Range near Garberville, latitude 40° 13' N., longitude 123° 55' W. (reported by R. E. Nelson, California Forest and Range Experiment Station); in Oregon, at 600 feet above sea level

near Myrtle Creek, latitude 43° 2' N., longitude 123° 19' W. (reported by W. I. Stein, Pacific Northwest Forest and Range Experiment Station). The best commercial stands are between 5,000 and 6,500 feet (19). Individual trees may be found up to 10,000 feet.

BIOTIC

Jeffrey pine is commonly associated with ponderosa pine, both with and without other species, such as sugar pine (Pinus lambertiana Doug.), California red fir (Abies magnifica A. Murr.), Shasta red fir (Abies magnifica var. shastensis Lemm.), white fir (Abies concolor (Gord. & Glend.) Lindl.), Douglas-fir (Pseudotsuga menziesii (Mirb.) Franco), incense-cedar (Libocedrus decurrens Torr.) and western juniper (Juniperus occidentalis Hook.). Pure Jeffrey pine stands, however, are common in a narrow belt on the east slopes of the central and southern Sierra Nevada and in the mountains of southern California. The common forest types in which Jeffrey pine is found are: Interior ponderosa pine, ponderosa pine-sugar pine-fir, Jeffrey pine, red fir, and western juniper (18).

Jeffrey pine is reported to occur between the upper limits of ponderosa pine and the lower limits of white fir (19). However, it frequently grows outside this belt--both in patches at lower elevations with ponderosa pine and as scattered trees at higher elevations with white or red fir.

In southern California Jeffrey pine is associated with California live oak (Quercus agrifolia Nee) and Coulter pine (Pinus coulteri D. Don).

In northeastern California common sagebrush (Artemisia tridentata Nutt.), bitterbrush (Purshia tridentata DC.), squawcarpet (Ceanothus prostratus Benth.), and greenleaf manzanita (Arctostaphylos patula Greene), are the most common shrubs associated with Jeffrey pine. In other parts of its range some of the common shrubs are whitethorn (Ceanothus cordulatus Kell.), greenleaf manzanita, bearmat (Chamaebatia foliolosa Benth.), and bush chinkapin (Castanopsis sempervirens Dudley).

LIFE HISTORY

SEEDING HABITS

Pollination occurs in May and June, and cones ripen in August or early September the following year. Most of the seeds are dispersed in September and October. At the Blacks Mountain Experimental Forest in Lassen County, northeastern California, approximately two-thirds of the seeds fall before November 1.

Although some cones are produced almost every year, abundant seed crops are produced at irregular intervals of 4 to 8 years. Cone production starts at 8 years and reaches an optimum at 150 years (3).

Jeffrey pine seed are disseminated by wind and rodents. They fall at the rate of 7.25 feet per second (17). On level ground, a 10-mile per hour wind will carry seed 300 feet as it falls from a height of 150 feet.

Insects attacking the cones and seed often seriously reduce the quantity of good seed produced. The more common pests are a cone-beetle (Conopthorus ponderosae Hopk.) and two pine cone moths, Laspeyresia piperana Kearf. and Eucosma babana Kearf. (9).

VEGETATIVE REPRODUCTION

Jeffrey pine does not reproduce naturally by sprouting or rooting.

SEEDLING DEVELOPMENT

Establishment

Jeffrey pine seeds are usually highly viable. Germination is generally better than that of ponderosa pine (3). In a seed-storage test, the germination capacity of Jeffrey pine seed was 93 percent; of ponderosa pine, 86 percent (15). In two direct-seeding tests with seed protected with screens, the germination was: First test, Jeffrey pine 98 percent and ponderosa pine 91 percent; second test, Jeffrey pine 86 percent and ponderosa pine 69 percent (8).

Jeffrey pine seeds are about twice as heavy as ponderosa pine, and they usually produce larger seedlings the first year. In one study the dry weight of Jeffrey pine 1-year-old seedlings was about 50 percent greater than that of ponderosa pine (7). However, the larger size of Jeffrey pine seedlings probably does not promote much better survival. Available data do not clearly show an advantage for either species.

The seeds of Jeffrey pine, like those of ponderosa pine, are readily eaten by rodents. Consequently natural regeneration or direct seeding generally are unsuccessful unless rodent populations are at a low level (from natural causes or control measures) or the seeds are protected as by screening. Except on a few small plots, direct seeding of Jeffrey pine without seed protection has failed.

Neither Jeffrey pine nor ponderosa pine can successfully be regenerated on areas occupied by competing vegetation. At the

Blacks Mountain Experimental Forest, the need for removal of competing vegetation was shown in tests of natural regeneration and of planted nursery stock. In a year of an excellent seed crop, rodents were poisoned in and around openings in a mixed ponderosa-Jeffrey pine stand. On bare ground, 33,329 ponderosa and Jeffrey pine seedlings per acre germinated, and 33 percent survived at the end of 4 years (20); on areas with heavy vegetation, 2,914 seedlings germinated, and 4 percent survived at the end of 4 years (20). In the planting test, second-year survival on bare ground was 62 percent for 1-1 Jeffrey pine and 71 percent for ponderosa pine, whereas on areas with heavy vegetation it was 0 for Jeffrey pine and 7 percent for ponderosa pine (13).

Cutworms and other insects frequently cause serious mortality among young seedlings.

Because of irregular seed crops and rapid invasion of cutover areas by other vegetation, artificial regeneration will be needed much of the time.

Early Growth

Jeffrey pine and ponderosa pine grow at about the same rate when present together under natural conditions. Compared with such associates as Douglas-fir, white fir, incense-cedar, and sugar pine, they have a rapid early growth if free from an overstory and other plant competition. On clear-cut areas which were free of vegetation after cutting, the average heights of Jeffrey pine, sugar pine, and white fir were 4.3 feet, 2.9 feet, and 0.6 feet, respectively, at the end of 8 years (16). In a plantation study in Plumas County, California, the average height of Jeffrey pine was 4.2 feet 9 years after planting (7). As is true of most fast-growing trees, several years after establishment are required before a maximum rate of height growth is reached. In stands free of competition and not overly dense, the period before maximum height growth is believed to be between 5 and 10 years for Jeffrey pine.

Seasonal height growth starts at about the same time as for ponderosa pine but earlier than for white fir and sugar pine (6). The average date was May 16 at an elevation of 5,200 feet at the Stanislaus Experimental Forest in the central Sierra Nevada. The average duration of height growth was 78 days at this locality. In Lassen County in northeastern California at an elevation of 5,000 feet, the average starting date of height growth was May 15.

Jeffrey pine frequently becomes established under open, overmature overstories. Under these conditions, however, its growth is very slow. Both Jeffrey and ponderosa pine seedlings 40 years or more in age and less than 3 feet tall are common in California stands. When released by removal of the overstory, Jeffrey pine begins rapid height growth after 3 to 7 years.

The pine reproduction weevil (Cylindrocopturus eatoni Buch.) frequently causes serious mortality in Jeffrey pine plantations (4).

SAPLING STAGE TO MATURITY

Comparative growth data for Jeffrey pine and ponderosa pine are not available. Jeffrey pine trees commonly look as though they were more vigorous than ponderosa pine and retain youthful appearance to greater ages where the two species grow together. Yet their growth rate, maximum size, and age appear to be similar. We believe that ponderosa pine growth and yield data can be used for both Jeffrey pine stands and mixed stands of Jeffrey and ponderosa pine.

The largest tree reported is 57 inches d.b.h. and 157 feet tall (1). However trees larger than 60 inches d.b.h. have been measured on the Blacks Mountain and the Stanislaus Experimental Forests. A Jeffrey pine 83 inches d.b.h. has been measured on the Inyo National Forest. Undoubtedly there are Jeffrey pine trees over 200 feet tall. A number of "yellow pine" trees taller than 200 feet are recorded in early volume table measurements. As ponderosa and Jeffrey pine were lumped together as yellow pine in early records, some of these trees probably were Jeffrey pine.

Jeffrey pine is long lived. Ages of 400 to 500 years are common.

Jeffrey pine usually occurs in both pure and mixed stands as even-aged groups of trees. The groups are from a fraction of an acre to 5 or 10 acres in size--rarely larger. Commonly a younger even-aged understory of seedlings, saplings, or poles is also present.

Jeffrey pine is rated as an intolerant tree in its light requirements--being similar to ponderosa pine in this respect (2).

On large areas with low precipitation (15 to 20 inches) on the east side of the Sierra Nevada, Jeffrey pine occurs as a climatic climax association either as pure stands or mixed with ponderosa pine. Where precipitation is higher and the more tolerant white fir occurs, Jeffrey pine probably is present only in subclimax stages of plant succession.

Even-aged management by small groups is indicated by the even-aged character of natural stands and by the more rapid growth of young stands without an overstory. We believe that for management purposes the optimum size of group is between 5 and 10 acres although this has not been definitely determined. The groups must be small enough to permit adequate seed dispersion from border trees after a reproduction cutting, and large enough to minimize competition from larger border trees.

COMMON PESTS

Porcupines cause extensive damage in sapling and pole stands by girdling the tops of young trees. Although they kill some trees, their usual damage is reduction in growth resulting from loss of crown and cull resulting from tree deformation. Occasionally they girdle and kill seedlings.

Dwarfmistletoe (Arceuthobium campylopodum Engelm. f. typicum Gill) causes extensive damage by reducing growth, especially in young age classes. It also is a contributing cause of mortality in mature trees. Dwarfmistletoe is more prevalent and destructive on the poorer sites.

A root rot (Fomes annosus (Fr.) Cke.) and a stain fungus (Leptographium spp.) cause considerable mortality in all age classes by killing the roots of Jeffrey pine.

A limb rust (Cronartium filamentosum (?) Peck) is common on Jeffrey pine in the central and southern Sierra. In the remainder of the range of Jeffrey pine the rust is restricted to an occasional tree. The rust attacks large saplings and older trees. Although the rust develops slowly it eventually kills the trees it infects.

The Jeffrey pine beetle (Dendroctonus jeffreyi Hopk.)--the principal insect enemy of Jeffrey pine--causes heavy losses in old-growth stands on the east side of the Sierra Nevada (5). Before the final harvest cut, losses in old-growth Jeffrey pine stands can be kept to a minimum by a sanitation-salvage cut in which the high risk trees--the ones most likely to be infested--are removed.

The California flatheaded borer (Melanophila californica Van Dyke) frequently attacks mature Jeffrey pine and may occasionally kill the tree. Usually it only weakens the tree before it is killed by bark beetles. The Oregon pine engraver (Ips oregoni Eichh.) attacks and kills the tops of mature Jeffrey pine.

SPECIAL FEATURES

An unusual feature of Jeffrey pine is that its turpentine is not composed of terpenes, as is that of most pines, but is composed of normal heptane, one of the paraffin hydrocarbons, with a small admixture of fragrant aliphatic aldehydes (14). This composition of Jeffrey pine turpentine may have a bearing on silviculture. For example, heptane may be extracted commercially, it affects rosin impregnation, and it may affect the resistance of this pine to some species of bark beetles.

RACES AND HYBRIDS

Jeffrey pine hybridizes naturally with both Coulter pine [1/] and ponderosa pine (11).

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